Image Processing and Computer-Aided Detection in Mammographic Images

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LONG-TERM GOALS

Our prior research efforts were directed primarily towards enhancement of and automated detection in side-scan sonar images. The problems associated with these images are very similar to those with mammograms: small, low-contrast targets imbedded in high clutter but a critical requirement to avoid false positives. Our goal is to apply techniques developed for naval images to mammographic images thus making a contribution to the development of a computer-aided diagnosis capability for mammographic data.

Second we want to expand the range of image processing techniques applied to naval image data by exploring and modifying methods used by medical researchers. In the process we hope to gain visibility and make contacts in the medical image processing community thus making us privy to cutting-edge methods being developed by medical researchers.

Finally, in order to make our work easily accessible to other researchers we will develop and maintain an image analysis toolset with an easy to use interface that can accommodate both naval and medical images.

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OBJECTIVES

In FY98 the development of algorithms to perform image enhancement, feature extraction, and target detection on digitized mammograms begun in FY97 will be completed. This will include the derivation of new contextual features for false target rejection.

These efforts will be documented and publicized through publications, patents, conferences, and collaborations with medical researchers.

Also, the DOCTOUR image processing toolset will be completed, documented, and patented.

APPROACH

Our efforts have concentrated on image enhancement and cueing to allow operator control rather than using a strictly automated approach. This makes the resulting product more valuable as a research tool. That is, a tool for people who want gauges rather than only warning lights.

The key individuals in this effort are:

- Susan M. Tuovila: software testing, background research, patent application preparation, and documentation;
- Susan R. Nelson: software development, image enhancement and analysis, presentations and marketing;
- Cheryl M. Smith: background research, morphological image analysis, and documentation;
- Mita Desai (University of Texas at San Antonio): wavelet image analysis, and contacts in the medical imaging community.

WORK COMPLETED

An extensive feature set to describe image areas and locate targets of interest has been developed. An array of image enhancement procedures that apply to both naval and mammographic images has been completed. Also an algorithm to detect microcalcifications to locate malignant lesions in mammographic images was developed.

A texture analysis algorithm was constructed and applied to electro-optic images collected by a laser line scan sensor. The algorithm uses variations in texture to create a detection mask for probable man-made objects.
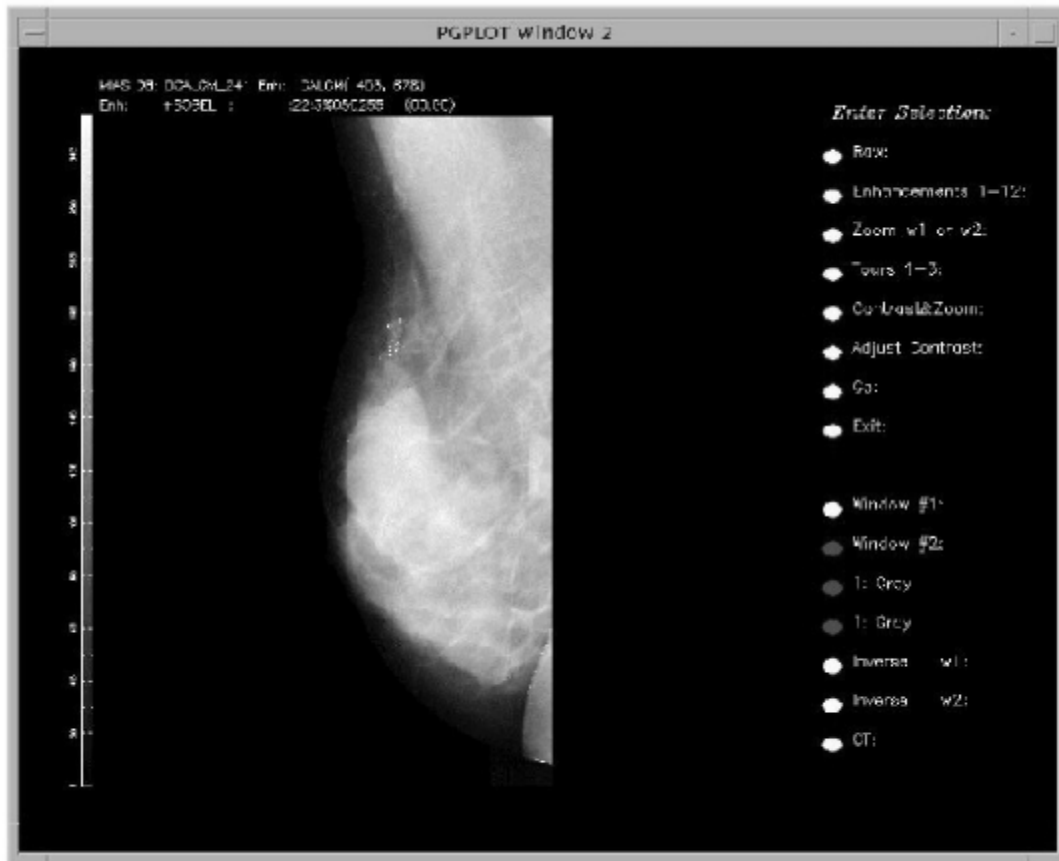
Three databases of mammograms (over 350 images) were reviewed.

The DOCTOUR image processing toolset was completed.

RESULTS

DOCTOUR is an interactive user-friendly toolset designed to allow physicians and researchers whose main interest is not image processing to apply sophisticated image processing techniques to images. It is primarily a visualization tool suited for use with both medical and naval images. The package may be used in a virtually automatic mode where a set of pre-selected techniques is applied to an image. Alternately it will allow full operator control, providing the user with powerful tools for exploring an image.

DOCTOUR includes all enhancements and target detection tools developed during this effort as well as many standard algorithms. The program now has a graphical user interface with on-screen menus and is currently being transitioned to the IBM PC platform. The figure below shows the DOCTOUR user interface.

DOCTOUR was chosen by the Merrick School of Business, University of Baltimore as a graduate project in its "Lab to Market" program. The program develops strategies for commercialization of technology.

We have established a continuing relationship with researchers at University of Texas at San Antonio and Brooke Army Medical Center. We have one joint proposal pending and expect to team with them in the future.

Also, our paper has been selected for presentation at the 1st International Workshop on Computer-Aided Diagnosis hosted by the University of Chicago. Our paper will be published in a widely used hardcover reference. As the University of Chicago group has been the leader in computer-aided diagnosis for mammography research for many years, we have achieved a level of acceptance in the medical image processing community.

IMPACT/APPLICATIONS

DOCTOUR and the enhancement and detection algorithms developed for it provide an excellent aid for image analysis. It is hoped that once people with image analysis problems but little image analysis background experience the power of these tools, they will embrace them.

The program is particularly suited to mammography screening, diagnostic mammography analysis, and training for radiologists who wish to specialize in mammography. It includes special applications such as an algorithm to detect the skin line. Also, suggestions from radiologists were incorporated in the design of the user interface. This tool may be most valuable in the diagnostic

setting where an anomaly has already been detected either by screening mammography or physical examination. In that situation time is not a key factor and the need to view the image in many different formats is greatest.

The framework for DOCTOUR is that of a general-purpose image analysis system.   It is easily adaptable to any image type. Specialized modules can be included to personalize the program to fit project needs. This flexibility makes DOCTOUR an excellent tool for navy projects viewing or analyzing image data.

TRANSITIONS

Efforts to market DOCTOUR as a diagnostic and/or training tool for radiologists specializing in mammography continues.

The DOCTOUR program along with all algorithms developed under this project will be installed at Brooke Army Medical Center. There a group of radiologists interest in exploring the benefits of computer aided diagnosis will apply the techniques to their images. They are expected to analyze 3000 images over the next two years.

RELATED PROJECTS

Dr. Mita Desai at the University of Texas at San Antonio will use DOCTOUR as a user interface for her wavelet analysis for mammography. It will be tested along with our algorithms by radiologists at Brooke Army Medical Center.

PUBLICATIONS

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